Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

LASKA OREGON WASHINGTON

PACIFIC
NORTH
WEST
FOREST AND RANGE
EXPERIMENT STATION

· USDA FOREST SERVICE RESEARCH NOTE

PNW-205 August 1973

A FREEZING TECHNIQUE FOR SAMPLING STREAMBED GRAVEL

by

William J. Walkotten, *Forestry Research Technician*

PNW FOREST AND RANGE
[illegible]
[illegible]
STATION LIBRARY COPY

ABSTRACT

This stream sediment sampling method removes a nearly undisturbed, stratified sample containing stream gravel, intergravel water, and organic material and allows sampling in rocky streambeds. The equipment is inexpensive, easy to assemble, and portable.

KEYWORDS: Sampling (-streams), sedimentation, streams.

INTRODUCTION

The need to sample gravel and sediment in rocky, salmon-producing streams of southeast Alaska led to the development of a freezing technique. It provides a nearly undisturbed, stratified sample containing stream gravel, intergravel water, and organic material; it should provide valuable information on gravel resedimentation after cleaning. In addition, the technique can be used to remove samples from some of the less compact soil types. The equipment is portable enough for sampling streams in remote areas. The technique makes it possible to determine percentages of various material sizes by position within the frozen sample, since even the finest sediments are locked into it. Further modifications may facilitate collecting aquatic bottom fauna for productivity studies.

DESCRIPTION

Rapid heat transfer is needed to freeze a gravel sample in a stream channel. My method uses liquid carbon dioxide fed into a copper tube inserted into the gravel. The liquid CO_2 vaporizes at atmospheric pressure and absorbs heat from the streambed, freezing the intergravel water. Once frozen, the sample is not easily damaged by removal from the sampling site. The technique provides a sample varying in size with the type of streambed material at the sampling location. Sample size averages about 500 grams of sediment (dry weight). Sampling depth varies with streambed texture but can reach 4 feet into fine gravel when the copper probe is placed by hand.

The equipment needed for gravel freezing is inexpensive and easy to obtain and assemble (fig. 1). The sampling probe is assembled from 1/2- or 3/4-inch hard-drawn copper pipe and fittings. A four-way-cross pipe is soldered to about 3 feet of pipe, and short 6- to 8-inch lengths of pipe are soldered into the three remaining openings on the four-way cross. This provides a strong handle needed to remove the frozen sample and a place to tie down the CO_2 delivery tube. A point, machined from brass, is soldered to the other end of the sampling probe; this must be a watertight joint. The 3/8-inch soft-drawn copper tube is cut to reach to the bottom of the probe; a flare tube fitting on the upper end is connected to the wire-reinforced CO_2 delivery hose with brass fittings.

The most convenient liquid CO_2 supply is an ordinary CO_2 fire extinguisher. The fire extinguisher bottle has an internal tube reaching to the bottom to provide liquid CO_2 in the upright position and also has a convenient valve and handle. A reasonable choice is the 15- to 25-pound size for portability, ease of handling, and adequate supply. Pipe fittings replace the fire horn on the bottle so the wire-reinforced supply hose can be attached. An additional valve is needed in the line to regulate the flow of CO_2 to the probe. Standard

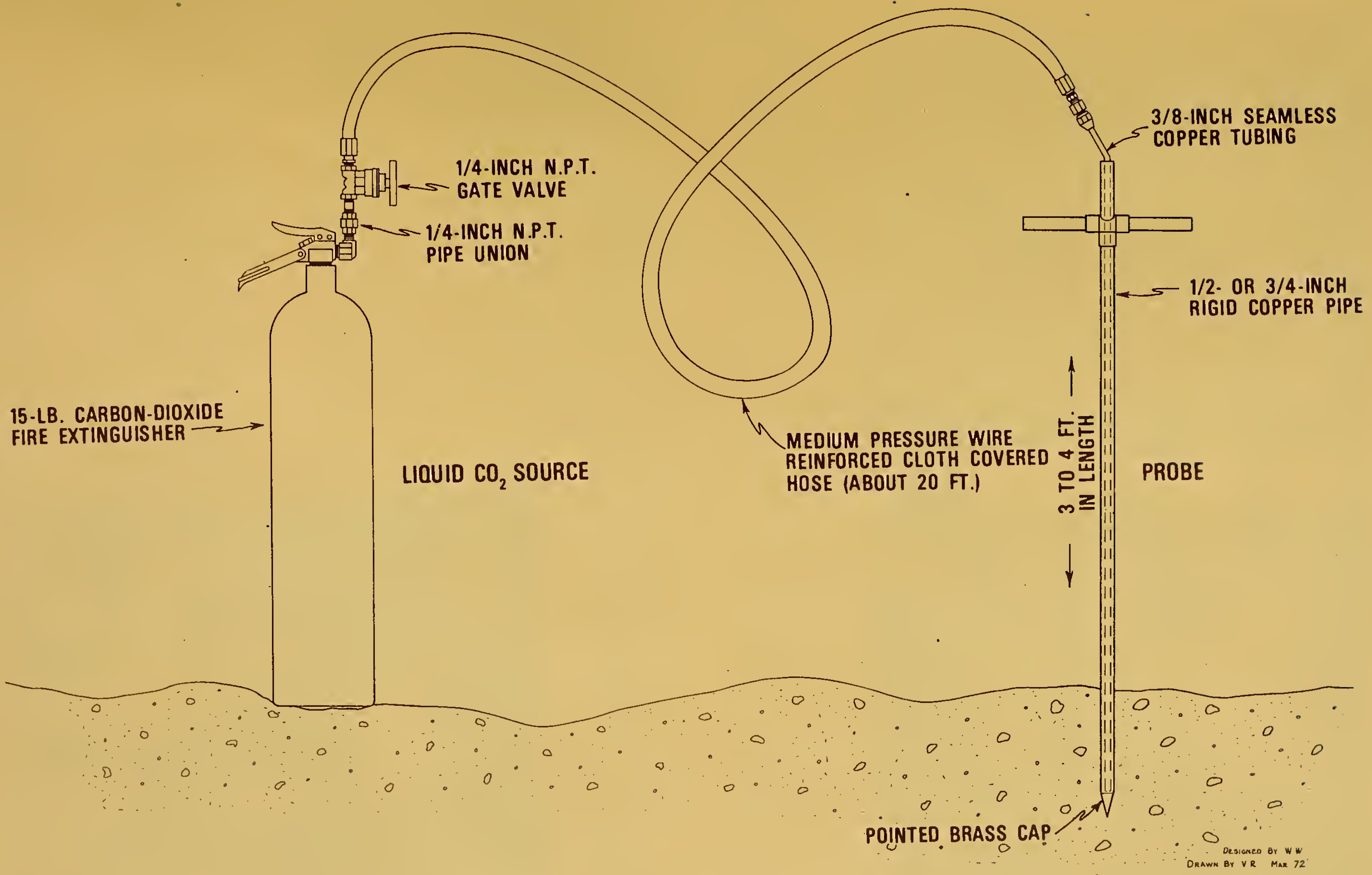
3/8-INCH SEAMLESS COPPER TUBING
1/4-INCH N.P.T. GATE VALVE
1/4-INCH N.P.T. PIPE UNION
1/2- OR 3/4-INCH RIGID COPPER PIPE
15-LB. CARBON-DIOXIDE FIRE EXTINGUISHER
LIQUID CO$_2$ SOURCE
MEDIUM PRESSURE WIRE REINFORCED CLOTH COVERED HOSE (ABOUT 20 FT.)
3 TO 4 FT. IN LENGTH
PROBE
POINTED BRASS CAP
DESIGNED BY W W
DRAWN BY V R MAR 72

Figure 1.--*Equipment for freeze-sampling streambed gravel.*

gas cylinders can be used; but they must be inverted to supply liquid CO_2, are heavy and difficult to handle, but have the advantage of providing a large gas supply.

OPERATION

This freeze-sampling technique allows great freedom in selecting sample locations (fig. 2). Any streambed location can be sampled, provided the probe can be pushed into it. Neither water movement nor depth seems to affect sample freezing. After site selection, (1) the probe is pushed into the streambed, (2) the 3/8-inch copper tube is inserted full depth into the probe, and (3) the tube is fastened to the probe handles. The CO_2 is turned on at a rate that blows carbon dioxide "snow" out the top of the probe. The best flow rate is about 1 pound per minute, but this is impractical to measure in the field so the proper rate is determined by watching the escape of gas from the probe. A little practice soon shows the most efficient use of the CO_2. If no "snow" or dry ice is blowing from the probe, use a faster flow rate; an excessive flow is spectacular, but wasteful. There is usually some momentary plugging of the 3/8-inch copper delivery tube during the freezing process when dry ice forms in the bottom of the probe. The plug clears in a few seconds with the release of CO_2 pressure in the hose. Back pressure can cause the delivery tube to jet out of the probe if it is not tied down.

Insulating properties of ice limit the size of sample that can be obtained. A maximum-size sample is frozen in 2 to 3 minutes and is solid enough to allow removal of the delivery tube and preparation of sample container before extracting the frozen plug from the streambed (fig. 3). The probe, with the adhering frozen sample, is then pulled from the streambed and is ready for examination.

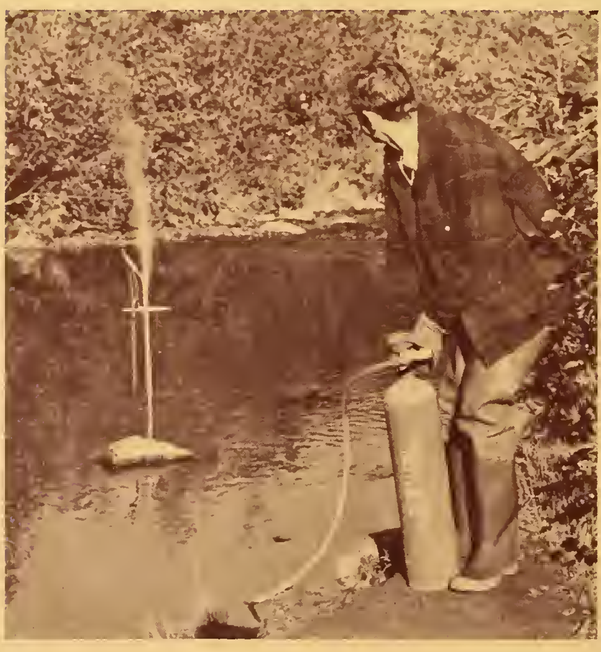

Figure 2.--*Freeze-sampling a small salmon stream.*

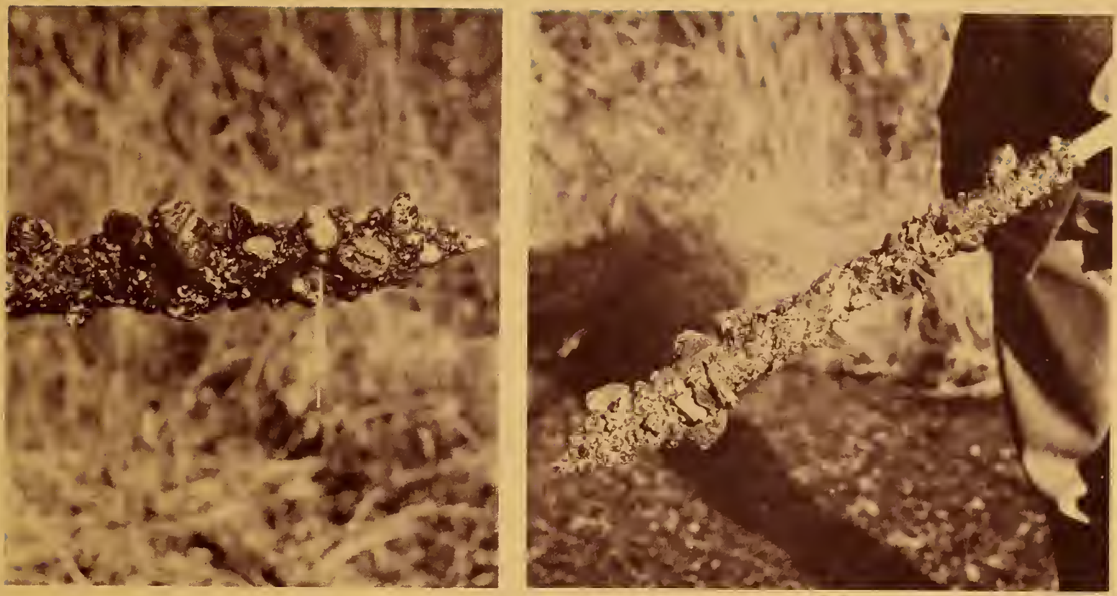

Figure 3.--*Examples of frozen gravel "plug" as removed from streambed. Arrow points to a live salmon egg.*

When sampling conditions are good and two probes are available, a sample can be taken every 5 minutes. About 2-1/2 to 3 pounds of CO_2 are used to obtain each sample. While sample weights vary greatly, primarily due to the particle size of gravel removed and probe depth, the average contains about 500 grams (dry weight) and 150 cc. of water.

The "plug" of frozen gravel provides a vertical section of the streambed to the full depth of sampling. It is certain that samples contain disproportionate amounts of larger gravel sizes, but for purposes of examining streambed deposition and sediment distribution this technique removes a nearly undisturbed sample. Intact frozen samples can be taken from the stream to the laboratory in cold weather.

Some caution is necessary when working with compressed CO_2. At atmospheric pressure, the released gas temperature is -108° F. (-78° C.), so dry, insulated gloves are needed for handling the valves, hoses, and probe. Tank pressure can exceed 800 p.s.i., so good tested hose and fittings are necessary in the event of plugging, and the delivery tube must be tied securely to the probe with a strong cord. CO_2 should not be used in a closed area,and safety glasses should be worn by the user.

Do not get water into the sampling probe or into the CO_2 delivery tube because ice will form rapidly and prevent escape of CO_2.

SAMPLE RESULTS

Both East Creek and West Creek, on the Young Bay Experimental Forest (northern Admiralty Island), were sampled above extreme high tide. These small, salmon-spawning streams are very rocky, fast-flowing, and carry high sediment loads during stormflow. Their rocky beds make standard gravel sampling extremely difficult.

By freezing the gravel, we pulled several random samples from each stream (table 1). The < 12.70-mm. screened fractions show a close percentage correlation between the two streams. The large difference in total sample weights between the two streams reflects the higher percentage of gravel in the >12.70-mm. size class in West Creek. It is interesting to note that the West Creek sample No. 8 also included 43 salmon eggs.

Table 1.--*Results of freeze-sampling two streams on the Young Bay Experimental Forest*

EAST CREEK

Sieve opening (mm.)	Sample number											X̄	S.D.	S.E.
	1	2	3	4	5	6	7	8	9	10	11			
	Weight retained (grams)													
12.70	179.6	135.2	657.2	0	280.5	265.7	0	120.3	25.6	70.1	33.6			
1.68	183.6	89.6	66.9	14.0	85.6	167.1	118.7	122.5	132.9	40.4	152.6			
.84	34.5	18.9	8.2	5.7	19.9	31.1	35.9	20.6	27.0	12.9	60.9			
.50	23.8	8.2	4.7	5.6	11.0	15.2	16.7	6.1	18.7	9.2	21.2			
.21	10.7	2.3	1.9	4.2	3.7	2.7	6.4	1.1	6.2	3.6	7.3			
.10	2.9	.7	.5	1.7	1.1	.5	2.6	.3	1.4	1.0	3.0			
< .10	1.9	.6	.2	.6	.8	.4	2.6	.3	1.0	.9	2.4			
Total weight	437.0	255.5	739.5	31.8	402.6	482.7	182.9	271.2	212.2	138.1	281.0			
Total weight (<12.70 mm.)	257.4	120.3	82.4	31.8	122.1	217.0	182.9	150.9	187.2	68.0	247.4	166.7		
	Percent passing													
12.70	71.3	74.5	81.2	44.0	70.1	77.0	65.0	81.2	71.0	59.4	61.7	68.8	10.90	3.29
1.68	13.4	15.7	10.0	17.9	16.3	14.3	19.6	13.7	14.4	19.0	24.6	16.3	3.90	1.18
.84	9.2	6.8	5.7	17.6	9.0	7.0	9.1	4.0	10.0	13.5	8.6	9.1	3.74	1.13
.50	4.2	1.9	2.3	13.2	3.0	1.2	3.5	.7	3.3	5.3	3.0	3.8	3.39	1.02
.21	1.1	.6	.6	5.3	.9	.2	1.4	.2	.7	1.5	1.2	1.2	1.41	.43
.10	.7	.5	.2	1.9	.7	.2	1.4	.2	.5	1.3	1.0	.8	.56	.17

Table 1.--*Results of freeze-sampling two streams on the Young Bay Experimental Forest*--Continued

WEST CREEK

Sieve opening (mm.)	Sample number									$\overline{X}$	S.D.	S.E.
	1	2	3	4	5	6	7	8	9			
	Weight retained (grams)											
12.70	251.3	357.3	545.6	57.4	1,152.3	686.1	1,178.0	511.3	1,005.7			
1.68	79.5	115.6	198.5	153.2	219.4	276.2	240.2	162.6	174.9			
.84	26.8	42.6	42.5	33.0	46.3	70.6	64.0	39.4	35.1			
.50	16.9	34.2	23.4	18.8	24.0	20.9	34.2	23.2	17.2			
.21	5.4	14.4	10.1	8.5	11.0	6.7	14.5	6.8	7.1			
.10	1.4	4.5	4.3	3.7	5.1	2.6	6.6	1.9	3.3			
< .10	1.0	3.3	4.5	4.2	5.2	2.5	7.7	1.5	3.3			
Total weight	382.3	571.9	828.9	278.8	1,463.3	1,065.6	1,545.2	746.7	1,246.6			
Total weight (< 12.70 mm.)	131.0	214.6	283.3	221.4	311.0	379.5	367.2	235.4	240.9	264.9		
	Percent passing											
12.70	60.7	53.9	70.1	69.2	70.5	72.8	65.4	69.1	72.6	67.1	6.22	2.07
1.68	20.5	19.9	15.0	14.9	14.9	18.6	17.4	16.7	14.6	16.9	2.29	.76
.84	12.9	15.9	8.3	8.5	7.7	5.5	9.3	9.9	7.1	9.5	3.17	1.05
.50	4.1	6.7	3.6	3.8	3.5	1.8	3.9	2.9	2.9	3.7	1.33	.44
.21	1.1	2.1	1.5	1.7	1.6	.7	1.8	.8	1.4	1.4	.46	.15
.10	.8	1.5	1.6	1.9	1.7	.7	2.1	.6	1.4	1.4	.54	.18

GPO 988-979

The mission of the PACIFIC NORTHWEST FOREST AND RANGE EXPERIMENT STATION is to provide the knowledge, technology, and alternatives for present and future protection, management, and use of forest, range, and related environments.

Within this overall mission, the Station conducts and stimulates research to facilitate and to accelerate progress toward the following goals:

1. Providing safe and efficient technology for inventory, protection, and use of resources.
2. Development and evaluation of alternative methods and levels of resource management.
3. Achievement of optimum sustained resource productivity consistent with maintaining a high quality forest environment.

The area of research encompasses Oregon, Washington, Alaska, and, in some cases, California, Hawaii, the Western States, and the Nation. Results of the research will be made available promptly. Project headquarters are at:

Fairbanks, Alaska
Juneau, Alaska
Bend, Oregon
Corvallis, Oregon
La Grande, Oregon
Portland, Oregon
Olympia, Washington
Seattle, Washington
Wenatchee, Washington

Mailing address: Pacific Northwest Forest and Range
Experiment Station
P.O. Box 3141
Portland, Oregon 97208